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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Industrial Pumps and their Lubrication

PUBLISHED MONTHLY BY
THE TEXAS COMPANY, U.S.A.
TEXACO PETROLEUM PRODUCTS

Give the Pump Its Due!

THE pump is the work horse of industry. In practically every field it is an essential in some phase of the process of production. It is rugged, it is durable. Regardless of its type, it has a happy faculty of "delivering the goods." Therefore, true to the natural instincts of man, it is neglected. Especially does this apply in the matter of lubrication.

Yet lubrication is a vital essential. Too often does a steam pump buck and groan; too often do the bearings of a centrifugal pump, for example, run hot. Why? Simply because something is wrong with lubrication.

In the current article we discuss the essential features of pump lubrication; we also deal with a few specific instances where pump lubrication is a decided problem.

And as a summary there is our list of Texaco recommendations, in detail, yet broad enough to apply to the majority of cases. But if your problems are more specific, if they are the kind that stump you when production demands are heaviest, *remember* there is Texaco Engineering Service based on

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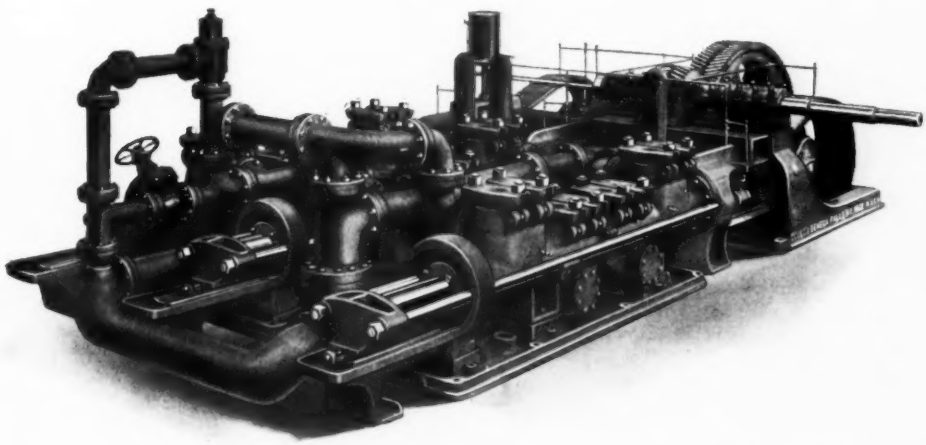


Courtesy of The Goulds Mfg. Company.

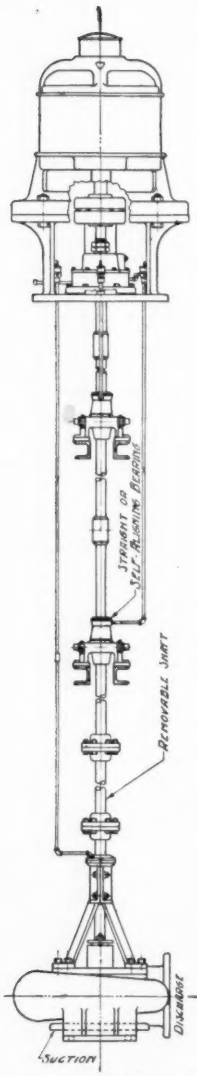
Fig. 1.—A double acting, outside end packed, horizontal triplex plunger pump. For service requiring high pressure and large capacities, a pump of this type is especially adaptable. Automatic lubrication is a feature.

Industrial Pumps and their Lubrication

THE extent to which fluids must be handled in the average industrial plant today renders the matter of pumps and their lubrication one of the salient factors in the attainment of maximum operating efficiency. The paper mill, the oil refinery, the textile dye house, the coal mine, the chemical plant, etc., to a large extent, all depend upon pumps for their operation. In fact, cut one or more important process pumps out of line and very often the average plant would be crippled, to a marked degree.

From the viewpoint of power consuming efficiency, the average pump will, like the mule, be a rather deceptive animal. It may be an insignificant little affair compared with the "race horses" of the industrial plant—the oil engine, steam turbine, paper machine, etc., but as a worker, in the face of detrimental conditions, it has few equals.

It will be generally agreed that as a rule pumping will be apt to involve heavy duty, the handling of large volumes, and the presence of solid or semi-solid foreign matter, all of which would impose loads of varying severity upon the pump dependent on its design and capacity. Withal these conditions, however, unless the average pump is of radically the wrong design, it will continue to function, though perhaps steam or power consumption per gallon handled



Courtesy of Dean Hill Pump Company.

Fig. 2.—A vertical, single suction centrifugal pump of the open shaft variety. Note lubricating piping leading to the respective steady bearings.

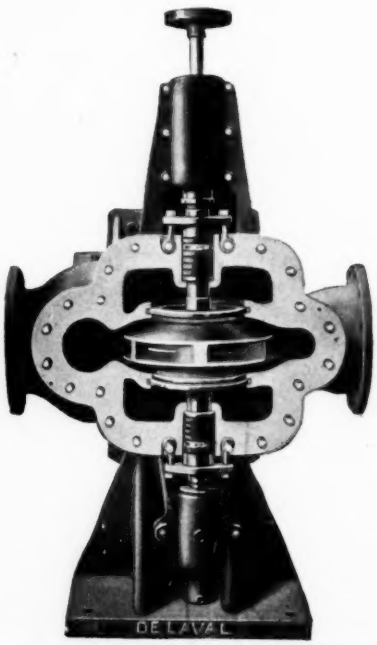
might rise abnormally. On the other hand, unless actual tests are run, such power increases, etc., may not be noticed, or at least not be traced back to the cause. As a result opinion will often be prevalent that as long as a pump keeps turning over it is doing the best that can be expected.

But this attitude of resignation often leads to impeded production. Especially is this true if resignation involves neglect and the operators come to feel that lubrication, for example, is an unnecessary luxury in the face of conditions which may not be conducive to ready application of lubricants. Normally, the replacement of worn parts, or the excess of power which will be required as long as they are continued in operation, will be more costly than lubrication, even though it may be a somewhat objectionable task to the operator.

To the layman, pump lubrication would usually be an apparently prosaic matter of applying more or less of the correct amount of whatever lubricant was required on adjacent machinery, to the rods, cylinders, rocker arms, bearings or gears of his pumps. Probably this idea has developed from extensive experience with the reciprocating steam pump so applicable to the handling of practically any type of liquid. In fact the reciprocating steam-driven pump is the "handy man" in nine out of ten plants today for this purpose. Whereas other designs might do the job better and more efficiently, the reciprocating pump will do it passably well, and, stuck away in a corner, even if forgotten, it will continue to function though it may groan and buck a little when the oiler overlooks it for a few days.

Such a condition is naturally not conducive to maximum plant economy. It may suffice in the boiler room, but in the handling of plant products such as paper pulp, liquid clay, chemicals, etc., where every endeavor is made to improve on process machinery, certainly the pumps should receive the same careful attention. In the modern industrial plant they are normally selected with a view to meeting production requirements of the adjacent equipment, therefore they should receive the same care in the matter of lubrication, for it is the lubricants to which we must turn in the attainment of maximum production. Just consider for example a faulty-operating slip pump in a clay working plant, or a pump handling still products in an oil refinery, with the packing torn out due to improper rod lubrication. Production must not stop, for it might disrupt the working of the entire plant. Yet the pump is practically out of commission—due to what? —usually sheer carelessness in lubrication.

We realize that in the handling of the multitude of fluid products met with in industry today, how complex may be the problems involved. Liquid clay is abrasive, gasoline and kerosene are solvents of straight mineral lubricants, acids are corrosive and tend to ruin valves, packing, rings, etc. So in each industry, pumping problems may develop which directly involve lubrication.

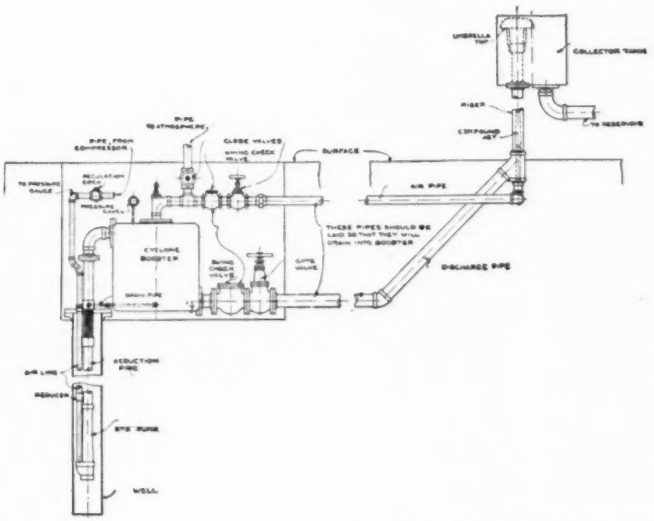


Courtesy of De Laval Steam Turbine Co.

Fig. 3.—Detailed view of a vertical submerged type of single stage, centrifugal pump. For submerged operation, the bearing brackets are piped so that oil can be fed from above and reclaimed in an overflow tank. A marine type or ball type thrust bearing carries the weight of the rotating elements.

Now lubrication is not a panacea for all ills, as the oil refiner who must pump gasoline will testify, but it is certainly a fairly good remedy

and very often a preventative. Furthermore, today there are so many more types of pumps available for selection in conformation with the duty required, that it is possible to anticipate and dodge certain of the difficulties with which the engineer of yesterday had to contend.



Courtesy of Sullivan Machinery Company.

Fig. 4.—An air lift, pumping installation. Note the essential features of construction. Systems of this character are excellent for deep well pumping.

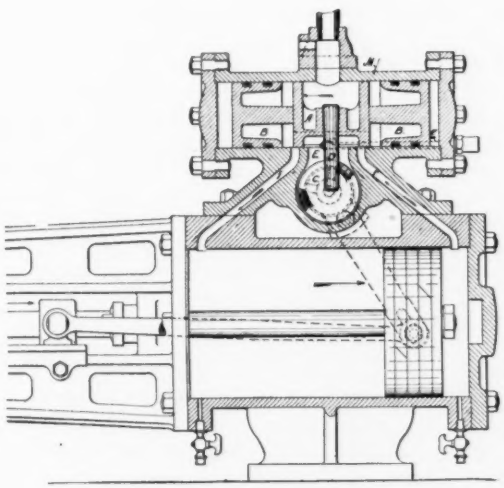
In a discussion of pump lubrication, not only must we bear in mind the types involved, but, likewise, the motive power. Broadly speaking we will have bearings, gears and steam cylinders to contend with, as embodied in the reciprocating plunger or piston type of pump, the rotary, centrifugal or the screw or geared device.

In regard to the motive power, we would in turn have steam, oil engine power and electric motors to consider, in various combinations with the above types of pumps according to plant conditions and economies required. Knowledge of the motive power is of importance only to the extent to which it may involve cylinder lubrication. The electric motor as adapted to a rotary pump for example, merely presents additional bearings to be lubricated. The steam driven reciprocating or centrifugal pump, on the other hand, includes the matter of steam cylinder lubrication, which may frequently be so in contrast to the lubricating requirements of the pump mechanisms that there will be considerable opportunity of faulty operation due to switching of the lubricants, or sheer carelessness in their choice or application.

Then again, oil engine cylinder lubrication may involve the same possibilities. Of course this can all be best understood by a study of the lubricating requirements of the several types of pumps in use today. Steam cylinder, turbine, oil engine and electric motor lubrication have been dealt with so extensively in previous issues of LUBRICATION that we feel it will only be necessary to casually refer to the silent features wherever necessary.

TYPES OF PUMPS

In general pumps can be grouped into two broad classifications according to the type of motion involved, i. e. (1) as to whether they bring about motion in a fluid by means of the reciprocating action of a piston or plunger; or (2) by the rotary motion of gears, screws or some form of rotor or impeller. Of course, the so-called pistonless pumps, such as the pulsometer, hydraulic ram, jet pump, etc., are a third type, but they are interesting merely from an informative viewpoint, for they require practically no lubrication. Therefore, they will not be included in this discussion.



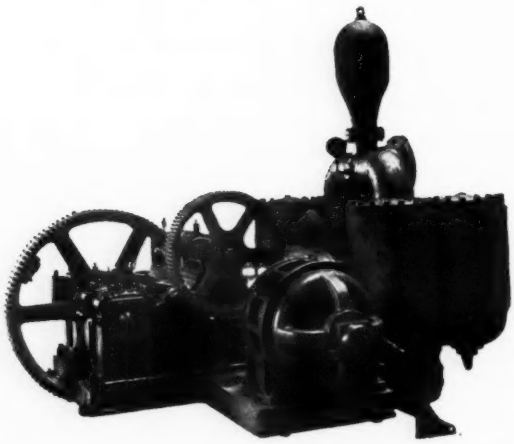
Courtesy of M. T. Davidson Company.

Fig. 5.—The valve gear of a horizontal single cylinder steam pump: Valve "A" is controlled by a steel cam "C." "B" and "B'" are the valve pistons. The parts are few and generally not subject to derangement from wear, etc.

Reciprocating Pumps

Under reciprocating pumps would fall all piston and plunger devices. Typical examples would be:

Single Cylinder, single-acting pumps.
Single Cylinder, double-acting pumps.
Duplex (two-cylinder) double-acting pumps.
Triplex (three-cylinder) single-acting pumps.
Triplex (three-cylinder) double-acting pumps.



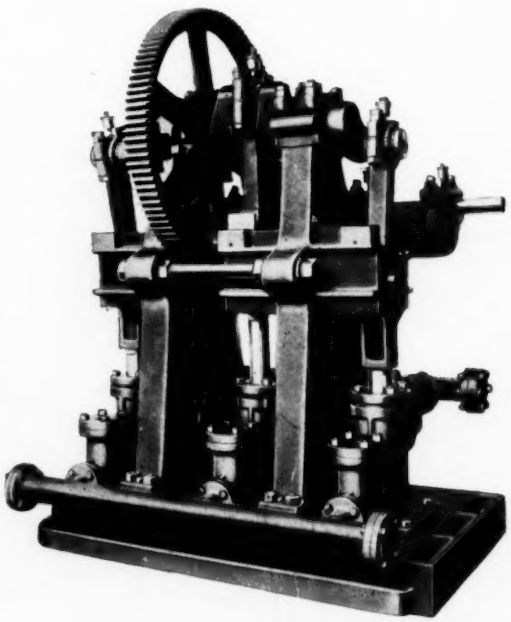
Courtesy of Union Steam Pump Co.

Fig. 6.—A duplex power cargo oil pump equipped for geared speed reductions. Note that gears are exposed, requiring, therefore, a highly adhesive grade of gear lubricant.

Reciprocating piston and plunger pumps are extremely flexible in regard to speed, pumping capacity and head. They furthermore show a relatively uniform efficiency curve under wide variations in the above conditions. They are, therefore, adapted for heavy duty, or service under adverse conditions. On the other hand with the exception of the triplex pump or others of more than two cylinders, there is very apt to be a certain amount of pulsation developed. In many cases this will not be objectionable, but where constant flow under uniform pressure is essential, as in the firing of fuel oil or the distribution of lubricating oil, it may easily be so detrimental as to materially reduce operating efficiency. Under such conditions, a type of geared, rotary or triplex pump would serve the purpose more effectively.

The operation of reciprocating pumps involves sliding friction between the essential operating parts. Broadly speaking, these will include pistons or plungers, valves, piston rods, valve stems, and the various external mechanisms that are required according to the type of drive installed. Reciprocating pumps are either steam or motor driven. Where steam is involved, the drive is usually direct with the exception of the larger, heavy duty units used in pumping stations, etc., where a crank and flywheel connection to a pumping engine is used. Electric drive reciprocating pumps, on the other hand usually require speed reduction mechanisms in the form of gears, chain belts or leather belts. With these latter, of course, we will also have to deal with rotary motion as involved in the bearings of motors, gear and sprocket shafts, eccentrics, connecting rods, etc., and also the combined rolling and sliding motion that will exist between gear teeth in operation.

The direct-action duplex steam pump is one of the most commonly used devices in the handling of fluid materials in the average industrial plant. Of low initial cost, economical in maintenance, and with an ability to function dependably under more or less detrimental conditions, it has gained an enviable position in the eyes of those who must keep production moving. But due to its relatively high steam consumption and slow speed, it is not always capable of meeting the loads imposed. From a lubrication point of view it is a relatively simple piece of machinery to handle under auspicious conditions. Due to the fact, however, that it will often labor along on excessively wet steam and exposed to dust, dirt, acid fumes, etc., it will usually require the most careful attention, for when such conditions are bad they are often extreme.

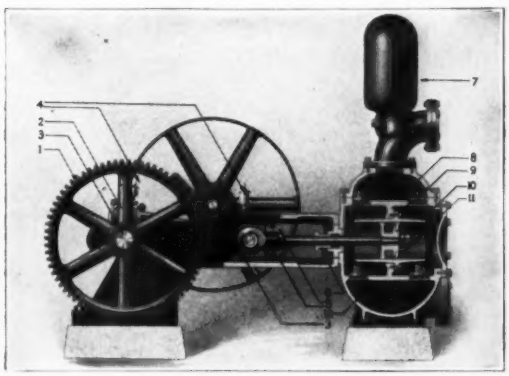


Courtesy of Platt Iron Works.

Fig. 7.—A vertical, single acting, triplex power pump capable of being driven by belt, chain, electric motor, oil or gas engine power. Note grease lubricated bearings and exposed gears.

Crank and flywheel pumps also involve steam power, but on such equipment it is received indirectly from a steam engine via a crank connection and flywheel. Reciprocating pumps of this character can be operated at

higher speeds than those which are directly connected, and hence can be expected to give higher economy. They are usually of higher first cost, and somewhat more expensive to maintain. In the matter of lubrication, however, the opposite should be true inas-



Courtesy of Fairbanks, Morse & Co.

Fig. 8.—A horizontal, belt driven duplex pump showing details of construction. Note sight feed drip oilers (4) which serve the guides and external bearings; the deep-throated stuffing box (6); the spring-expanded packing ring (11); and the adjustable shoes on the crosshead (5) to take up wear and maintain alignment. All promote ready and effective lubrication.

much as the average crank and flywheel pump will be located in such a manner as to render its care, inspection and lubrication a matter of but little difficulty. Nor will steam conditions tend to be as extreme as where direct connected pumps are involved. In fact a pumping engine will, as a rule, be served with relatively dry steam due as much as anything to the fact that in many instances the pump-house will be in close proximity to the boiler house.

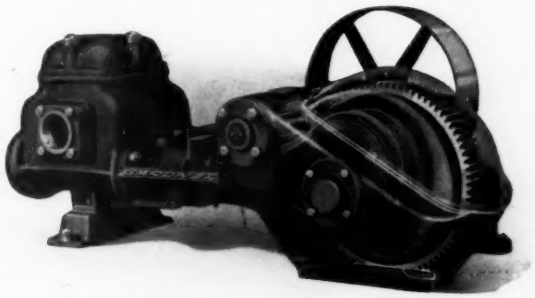
Lubrication

For the lubrication of reciprocating steam pumps we will usually be confronted with the necessity for two basic types of lubricants, i. e., one to serve the internal parts such as steam cylinders and valves; the other to serve the external wearing mechanisms such as rocker bearings, guides and rod connections. For steam cylinder lubrication we can, as a general rule, regard the steam pressure as the salient factor, assuming 150 pounds pressure as the dividing line in the choice of oils. Saturated steam will predominate, so the discussion is based on this assumption. Above 150 pounds, for example, an oil of somewhat higher viscosity would be required than for lower pressure conditions. Too, a little less fixed or animal compound will be required due to the fact that there will probably be less moisture in the steam and less chance of washing action affecting the lubricating film once it is formed.

External bearing lubrication can be taken care of either by means of oil or grease according to the lubricating devices installed. In general plain babbitted bearings will predominate. Where oil is required a medium viscosity (200 to 300 seconds Saybolt at 100° Fahr.) straight mineral product will generally be satisfactory. For grease lubrication a medium consistency cup grease will be best in compression grease cups, although a somewhat more fluid product may be necessary for pin type cups.

Coming to the triplex and those other types of pumps, however, which involve more than two cylinders, or the vacuum and air pumps, we will find that steam as the motive power is more or less secondary to electricity, or the practice of driving the pump through a suitable connection from the main engine. Especially is this latter true with marine types of air pumps which are used to reduce engine back pressures as much as possible by removing air from the condensers. In fact this, as the name implies, is the essential function of an air pump. The vacuum pump, on the other hand, is more extensive in its application and can be used in other fields wherever air is to be removed from receivers or various products, such as electric light bulbs for example.

The modern triplex pump is one of the heaviest duty devices in use today. It is especially adaptable to the handling of petroleum products, and oil emulsions for medicinal, food or lubricating purposes where the perfection of homogenuity of the mixture must be maintained. Constant and even pressures are a requisite in this regard. As a rule the triplex pump will be power driven through a suitable

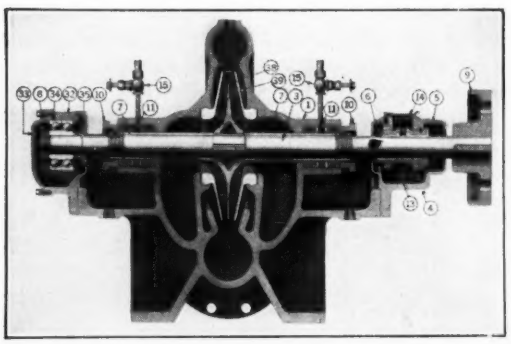


Courtesy of The Gardner Governor Co.

Fig. 9.—Inside view of the power end of a horizontal pump showing bath lubricated main gear which, in turn, delivers oil to suitable channels leading to the bearings. Continuous lubrication is a feature.

train of gears. These latter will usually be of heavy construction and designed to operate exposed. Furthermore their location in many cases will involve operation under detrimental conditions such as dust, dirt, chemical fumes or water, so their lubrication will require care-

ful attention. The ideal in any machine is to seek for noiseless operation, provided that the gears are carefully cut. This can be practically attained by use of the right amount of the proper kind of lubricant. The essential characteristics of this latter will, in general,



Courtesy of Allis-Chalmers Mfg. Co.

Fig. 10.—Section through a single stage centrifugal pump. Of particular interest are: The oil ring (13); the oil hole cover (14); and the ball bearing, housing, cover and oil slinger (32) to (35) incl.

be its viscosity and ability to adhere tenaciously to the teeth. The viscosity or body of such a lubricant would naturally have to be based on operating conditions such as speed, size of teeth, temperature and the amount of contaminating foreign matter involved. Needless to say a high degree of adhesion is always an essential where exposed gearing is involved. As a general rule a straight mineral gear compound of from 1000 to 2000 seconds Saybolt at 210° Fahr. will give the best results, although an even heavier product may be required under certain conditions.

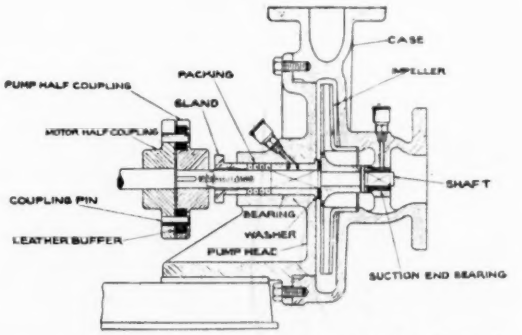
On such pumps, gear shaft bearings, connecting rod and pin bearings will, in turn, be subjected to pressures commensurate with the duty involved or the pressures that must be pumped against. These latter, to a great extent, will be dependent on the viscosity and volume of the product being pumped. To meet such bearing pressures both grease and oil lubrication are applicable. According to the size and importance of the pump certain builders will prefer to install compression or pin type grease cups; others, in turn, will provide for oil, using either sight feed oil cups, ring oilers or some more or less simple form of pressure lubrication. Grease lubrication is advantageous in that it will, as a rule, prolong the filling interval and in the case of the pin type of cup, render lubrication practically automatic. It is economical and positive, but for these very reasons may sometimes be ineffectual, especially where an excess or flood of lubricant might be required, under abnormal pressure or temperature conditions. As a result oil lubrication will, in turn, be preferred by many operators, even though more attention may be involved. The force feed lubricator, or ring oiler, of sufficient capacity, of course, reduces this matter of attention to a marked degree. Ring oilers are especially adapted to the lighter pinion shaft bearings.

CENTRIFUGAL AND ROTARY PUMPS

Mention has already been made as a matter of introduction, in regard to the several types of pistonless pumps which are used to transfer fluids by means of rotary motion. Of these the centrifugal pump is perhaps the most generally used in industry as a whole. The principle of rotary pumping such as is embodied in the screw pump, cycloidal, centrifugal, or other impeller device, etc., is distinctive in that it involves no valves, springs, or other small parts to wear out or become inoperative. Furthermore there are no internal parts which require lubrication.

Centrifugal Pumps

The centrifugal pump involves essentially one or more rotors or impellers revolving in a fixed plane within a suitable air tight casing. The liquid is received at the hub or centre of the impeller, pressure being acquired as it is impelled outward to the circumference, via suitable blades. Dependent on the type, fixed discharge valves are used similar to stationary nozzles, or a suitably designed spiral casing is employed for discharge purposes. Volute pumps are of this latter type. In order for a centrifugal pump to attain maximum efficiency it must function free from air

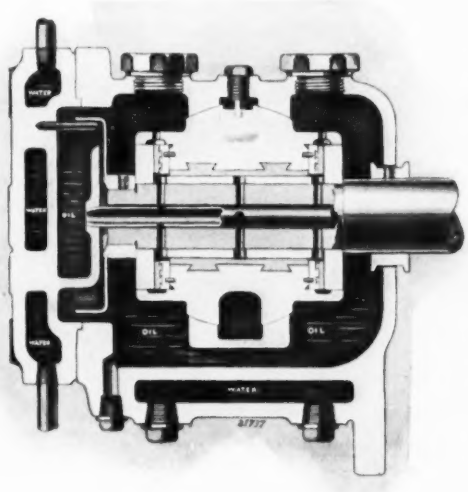


Courtesy of The John H. McGowan Co.

Fig. 11.—Details of a single stage, side suction centrifugal pump. Note grease lubricators on the impeller bearings.

leaks not only in the suction but also in the pump; the discharge pipe must be of such a diameter as to insure the delivery of the liquid with a minimum of friction; the operating speed must be commensurate with the pumping head; and there should be a minimum of sharp bends and elbows in any piping involved.

The centrifugal pump is a valuable piece of machinery where variable pressure and volume conditions are involved. In the textile mill, the steel plant, the paper industry, or for fire pump service, etc., it has proven its ability to satisfactorily meet the conditions involved.



Courtesy of Ingersoll-Rand Co.

Fig. 12.—Thrust bearing details (Kingsbury Type) as applied to a Cameron multi-stage, turbine centrifugal pump. A feature is self-alignment, which insures perfect distribution of bearing load.

In fact, whatever the product, be it pulp, sewage, acids, lime, boiler feed water, mine water, molasses, syrups, milk, etc., each with its respective problems, can be handled effectively by the centrifugal pump.

Rotary Pumps

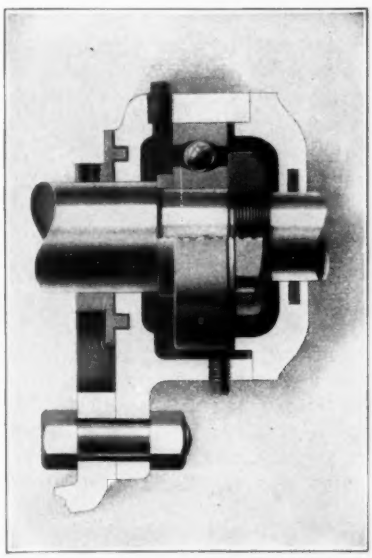
Pumps with two rotating elements are commonly known as rotary devices, whether these elements are gears, screws, pistons, impellers, or cycloids. Essentially the principle is that of the geared pump, the matter of teeth or lobes being the criterion. Pumps of this nature are of advantage where tar and other viscous liquids are to be handled. With certain types such as the cycloidal for example, while the discharge is continuous it is not uniform, therefore air chambers are usually required on both the suction and discharge sides. These chambers act on the principle of the accumulator or fly wheel, absorbing any excess of product at the time of maximum flow to discharge it at the time of minimum flow, thus insuring uniform velocity.

Lubrication

While pumps of this character will involve essentially the lubrication of bearings, these latter may be of a number of designs, and involve specific problems according to the operating conditions and the fluids being pumped. As a result they require serious consideration and can not be passed over as mere instances of ring oilers, ball bearings, etc., or plain babbitted bearings served by oil or grease cups.

For general all-round service on horizontal pumps the ring oiler is preferred by many builders due to its comparative simplicity, cleanliness, the extent to which it brings about automatic lubrication, the small amount of attention which it requires, its economy, and the uniformity and regularity of oil distribution.

In construction the ring oiler comprises a bearing housing which is built with a reservoir and a slot of sufficient width and depth to permit one or more rings suspended from the shaft to revolve therein. As a result, with the revolution of the shaft, these rings being subjected to rotation, will carry a certain amount of oil to the top of the shaft from whence it is able to flow into the bearing oil grooves and clearance space to be ultimately distributed to the entire wearing surface. As a rule, the oil after being passed through the bearing, will flow out to the end or ends of the shaft through a suitable return chamber which is part of the bearing housing, back to the oil reservoir below. Ring oilers, however, are not usually

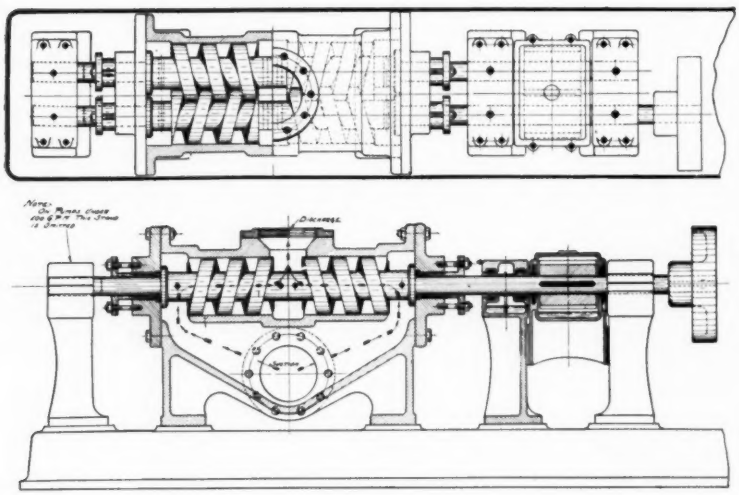


Courtesy of Fairbanks, Morse & Co.

Fig. 13.—Sectional view of a ball bearing mounting used in centrifugal pump design to promote power economies and reduce lubrication troubles.

recommended for bearings below two inches in diameter, especially where high speeds are involved, due to occurrence of excessive slippage of the rings, and the possibility of foaming arising in the oil where reservoir capacities are limited.

Ring oiling is today regarded by many as the simplest adaptation of the most efficient method of lubrication whereby the bearings are flooded with a considerable excess of oil over the amount that would theoretically be necessary to furnish the requisite oil film. By flooding the bearing with oil, the latter serves not only as a lubricant, but also as a cooling medium to carry away part of the frictional heat developed, thereby reducing the temperature of operating. If the oil reservoir in the base of the bearing has been properly designed and is of sufficient capacity, this overheated oil will have ample opportunity to become sufficiently cooled after each circulation by contact with the reservoir walls, particularly if the radiation of the latter is not interfered with. Lubricating systems of this nature possess natural advantages in that the flood of oil which is constantly passing through the bearings, tends to wash out any grit, dirt, dust or metallic particles that may have gained entry, as a result, reducing wear to a minimum. On account of this washing action of the oil, however, the reservoir will gradually tend to accumulate a certain amount of sedimentary deposits. Therefore, it should be flushed out and cleaned at intervals, the old oil being replaced with new or purified oil. This is especially important when such a system is new and core sand, etc., may be present. In such cases several weekly changes are recommended.

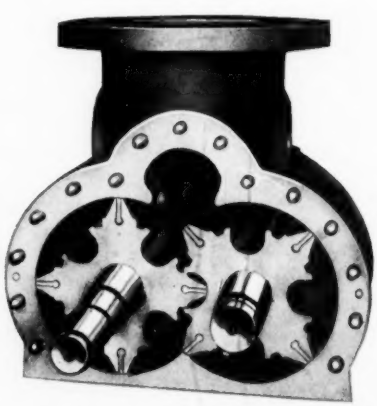


Courtesy of Wm. E. Quimby, Inc.

Fig. 14.—Top and side views of a screw pump showing relation of the screws which act as pistons in propelling the liquid through the pump chamber. The discharge at the center eliminates end thrust, therefore ring oiled screw-shaft bearings, and the gears are the only parts requiring lubrication.

It is evident that flood lubrication works on the opposite theory to that of supplying a bearing with just sufficient oil to furnish the necessary lubricating film. In fact, today in many types of machinery, flood lubrication is the only method allowed by the builder. On the other hand, there are many arguments in favor of regulated lubrication such as embodied by the drip cup or automatic force-feed lubricator.

Ball or roller bearings are, however, preferred on certain of such types of pumps. They are advantageous in that they supplant sliding motion with rolling motion, thereby theoretically reducing the resultant friction where properly lubricated. Ball bearings involve point contact, whereas roller bearings involve line contact. In the lubrication of either type, however, one of the chief functions of the lubricant is to prevent corrosion of the highly polished surfaces. As a result, wherever possible the housings should be oil-tight for thereby can we reduce the viscosity of the lubricant and in consequence the internal friction that will be developed during operation. Usually an oil of a viscosity in the neighborhood of 100 second Saybolt at 100° Fahr. will give the best results under such conditions.

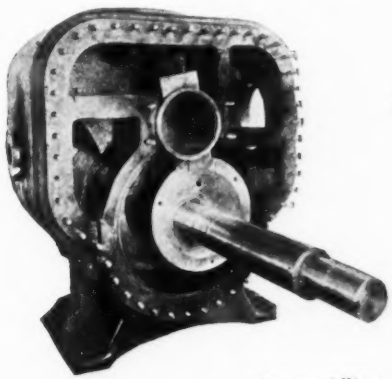


Courtesy of Northern Pump Co.

Fig. 15.—The rotors of a rotary pump showing relation of teeth. In such a pump there are no loaded sliding surfaces requiring interior lubrication. Each shaft is mounted on ball or roller bearings according to the service involved. The pilot gears are encased and run in a bath of oil.

Where leakage is possible, however, a grade of semi-fluid grease should be used which will have just enough body to cause it to remain in the bearing housing. Lubricating attachments are usually unnecessary on such bearings,

it being customary to charge or fill the housing and raceways with the proper grade of lubricant, through a suitable hole which can be effectively sealed or plugged during subsequent operation to prevent the lubricant from flowing out. In general one charge of oil to a roller



Courtesy of Kinney Mfg. Co.

Fig. 16.—Interior view showing constructional features of a rotating piston type of pump. Cams actuate the pistons. To facilitate internal lubricating holes are drilled through the pistons. There is no mechanical contact between the pistons and cylinder, therefore a minimum of wear accrues.

or ball bearing equipped with an oil-tight housing should last for a period of several months. Where grease is required, however, it should be renewed once a month or more often, according to the extent of seal which is maintained.

All rotary pumps, however, will not require or be equipped with ring oilers or anti-friction bearings. In certain cases grease cups, or sight feed oiling devices may be regarded as suitable by the builders, especially where operation is to be more or less intermittent. For such service a medium bodied engine oil or a plastic grade of compression cup grease will in general be found to serve the purpose in a satisfactory manner.

TYPICAL PUMP LUBRICATION PROBLEMS

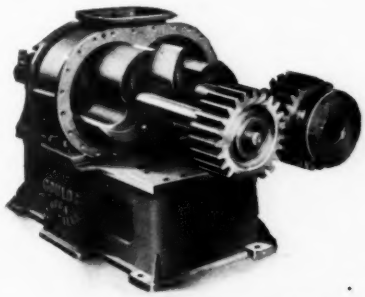
To further emphasize the importance of pump lubrication, it will be of interest to deal more or less intimately with a few of the typical problems that will be more commonly met with in certain industries. By bringing out the nature of these problems and the manner in which their solution can be usually effected, it is felt that this matter will be illustrated most vividly, thereby proving most helpful.

Deep Well Pumping

The lubrication of Deep Well Centrifugal Pumping Machinery is a problem in the irrigation and water works field, where water must be raised from considerable depth. For this purpose vertical centrifugal pumps are often used. Water is usually brought to the surface through a pipe within which the pump shaft is located. This shaft carries one or more impellers, according to the depth involved, the amount of water to be pumped, and the size of the well casing. It is the function of these impellers to raise the water at the requisite rate of discharge. Rotation is usually brought about by means of electric motor power. Due to the speeds of operation, which may range from perhaps 700 to 1800 R.P.M., direct drive is possible, although belt connections are perfectly feasible and frequently more practical.

One of the essential lubricating problems on such pumps is to take care of the steady bearings in the cover pipe. These latter serve to center and hold the shaft in proper alignment, prevent deflection and maintain the requisite pressures with as vibrationless operation as possible. But only can these ideals be attained through the medium of effective lubrication. Essentially, the lubricant should be so constituted that it will (1) maintain the requisite lubricating film; (2) have as little tendency as possible to run out at the bottom of the pump from between the shaft and casing or cover pipe; and (3) show as little internal friction as possible, for otherwise this would act as a brake on the impeller shaft.

Water can of course be used as a lubricant on such pumps, especially where a cover pipe is not employed. It is effective, economical



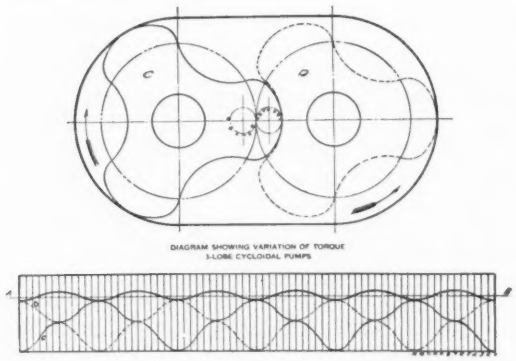
Courtesy of The Goulds Mfg. Co.

Fig. 17.—Open view of a rotary pump showing design of case and cams. Due to accurate machining a high degree of vacuum is attainable with such a pump.

and prevents the possibility of contamination of the water being pumped. Under certain conditions of sand, or the presence of other such fine particles of foreign matter in suspension, it is, however, generally considered better practice to provide for oil lubrication, installing a suitable cover pipe and bearings of design capable of bringing this about. Where water is the lubricant, these latter are oftentimes of rubber or hard wood.

Whatever the type of lubricant, however,

the design and location of the bearings is a most important feature. Usually they must be located relatively close together. On one well-known pump this distance is approximately eight feet.



Courtesy of The Connersville Blower Co.

Fig. 18.—The impeller arrangement in a three-lobe cycloidal pump. Alignment is important, therefore, journal bearings are carefully designed to afford both the requisite support and lubrication to the impeller shafts.

Where lubrication by means of fluid oil is practicable, due to the high speeds involved, it will usually be best to use a comparatively low viscosity product. In general a viscosity of from 180 to 200 seconds Saybolt at 100 deg. F. will serve the purpose, providing that the stuffing box in the bottom of the cover pipe gives the requisite seal.

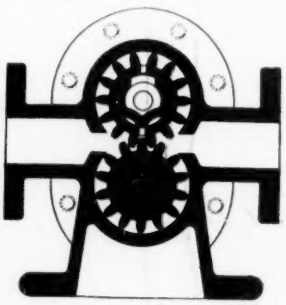
Under conditions of a marked difference in head, however (especially where automatic circulation of the oil is not provided for) the oil might exert a pressure on the openings around the bottom bearings so much greater than would the water in the well (particularly when the pump is not operating) that this oil would run out at the bottom between the shaft and cover pipe, if the stuffing box happened to be worn to any extent. This occurrence will be indicated by an excessive consumption of oil. The procedure in such a case would be to resort to a grade of liquid grease which will not only be capable of giving adequate lubrication with as low a drag as possible, but also will have sufficient body to resist the unbalanced pressure which may be involved. As wear on the stuffing box increases, it may in turn be necessary to use a heavier grade of grease, though of course this may involve the sacrifice of a certain amount of mechanical efficiency. Such a grease should have a consistency very nearly the same as that of vaseline, and should be a product which will retain its plasticity at the approximate temperatures of pumping.

The adaptation of automatic balanced circulation lubrication, whereby oil is fed from a surface tank so located that oil and water pressures will be equalized is claimed to eliminate the possibility of waste and contamination of the well water. This oil is pumped through the bearings and back via a return pipe, by a suitable lubricant pump. Such a system makes possible the continued usage of a fluid lubricant capable of giving the desired results with the least development of internal friction. Of course it requires the use of a suitable cover pipe, within which the shaft and steady bearings are located. Here, the problem is much the same as involved with a turbine, excepting that the temperatures are lower. Therefore, oils of approximately the same viscosity as mentioned above should function satisfactorily.

Mine Pumps

Another type of pump, the operation of which may often involve lubricating problems is the Mine Pump so necessary in the anthracite coal fields, etc. Here water conditions may be very bad, therefore, it is necessary to employ the most rugged type of heavy duty pump to keep the sumps and galleries clear. For this purpose naturally many makes of pumps are used. In general, however, they will involve either the horizontal reciprocating steam or air driven pump, the vertical motor-driven triplex pump or the centrifugal pump.

Where bearings alone are involved as in the motor-driven centrifugal pump, lubrication will be a relatively simple matter. Ring oilers predominate and these can usually be taken care of by means of a medium bodied straight mineral engine oil of from 200 to 400 seconds Saybolt viscosity at 100° F. This same oil can also be used with satisfaction on the external bearings of reciprocating pumps. In lieu of oil, however, certain builders will prefer grease due to the fact that frequently there will be less chance for dust or dirt gaining entry to score or abrade the bearings. With either the compression or pin type of grease cup, a medium bodied cup grease will serve the



Courtesy of Schutte & Koerting Co.

Fig. 19.—Side elevation of a high pressure geared pump, which is adaptable to the handling of fuel oil and other such products. The lower is the driving gear, the upper being the idler.

desired purpose. It is furthermore of advantage wherever shaft ends are exposed, for a seal of grease will prevent the entry of dirt more readily than an oil film due to its higher consistency and ability to "stay put."

Courtesy of Rider-Ericsson Engine Corp.

Fig. 20.—A horizontal centrifugal pump and receiver adapted especially for boiler water return pumping. Bearings are ring-oiled. This pump is operated via a control in the receiver, the water level in the latter actuating a suitable float and switch.

Bearings, however, are the least of our troubles in mine pump lubrication. It is with plungers that we will be more usually concerned, for the plunger pump is very extensively used so adaptable is it to the conditions involved. These pumps are usually of the outside packed plunger type and require a lubricant which will keep the packing properly sealed and prevent excessive wear on the plungers. Years ago operators used to prepare their own lubricants for this purpose, stewing up various concoctions of tar, tallow, cylinder oil and perhaps engine oil. Sometimes these worked fine but like most "home-brew," the "kick" often developed in the wrong place. In other words, packing might be pulled out, or excess power consumed to bring about operation were the lubricant too thick, or, leakage developed were it too thin to maintain the requisite seal.

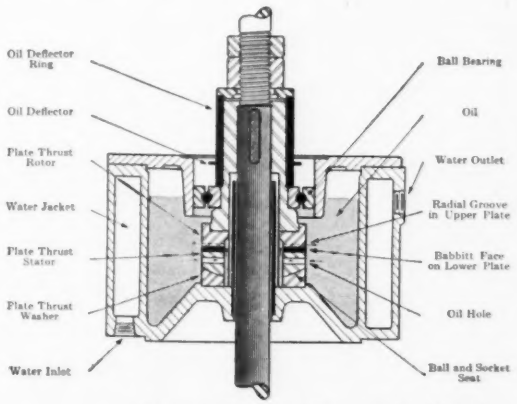
Progressive operators have therefore turned to a relatively high viscosity (1000 to 2000 sec. Saybolt) straight mineral lubricant for this purpose. Not only will such a product lubricate the plunger, but also it will seal the clearance space effectively and lubricate the packing so that there will be little or no danger of this being damaged. Another advantage of such a lubricant is that it will adequately protect the plunger from the corrosive effects of sulphurous compounds with which the mine water may be contaminated.

Light Oil Pumping

Where products such as gasoline and light oils are being pumped which would tend to cut or absorb lubricating oils, etc., the sealing and lubricating problem becomes of paramount importance. In both the reciprocating and rotary pump this will involve rod, plunger or shaft stuffing boxes. Essentially it is more of a sealing than a lubricating problem in that if an adequate seal can be maintained and leakage of the fluids into the main area of bearing prevented, the matter of lubrication should not be relatively difficult. Numerous types of packing or stuffing box material have been tried out in this regard, for the pumping of gasolines, etc., under higher pressures and temperatures is one of the most important problems in the oil industry. In the case of the rotary pump it is perhaps the more pertinent due to the fact that the same shaft area is continually under contact and subject to the effects of friction; too, shaft flexure must also be considered. In other words the packing must have a certain amount of resiliency and life and must be highly resistive to deadening, otherwise it may fail to serve its purpose with the result that leakage and cessation of lubrication would probably occur. The natural tendency in such cases would be to tighten up on the stuffing box glands with the probable result that the shaft would be ultimately scored and cut.

To surmount this difficulty the packing must be resistive to heat transfer, capable of forming a tight seal, and not readily affected or disintegrated by the products being pumped.

With plunger and piston types of pumps there is a greater area of the plunger or piston

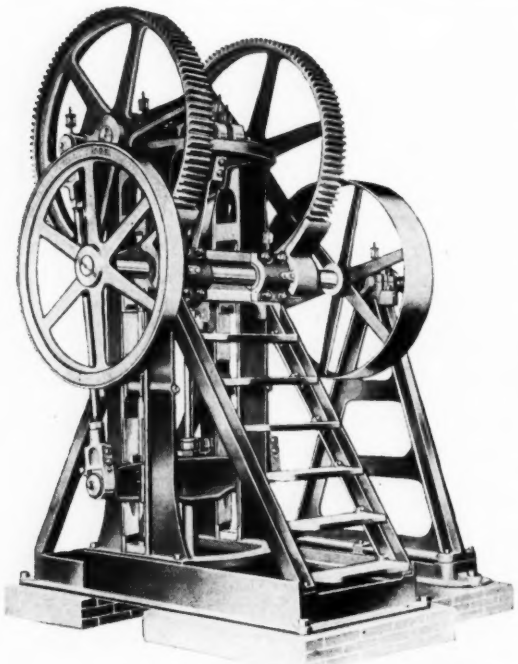


Courtesy of Worthington Pump and Machinery Corp.

Fig. 21.—Section through a deep well pump thrust bearing. Essential constructional features are clearly indicated. This bearing runs submerged in oil. The oil bath is water jacketed.

rod subjected to sliding contact. Reciprocating motion, in addition is more conducive to the development of packing leaks, and scored surfaces due to impaired lubrication. As a result on such types of pumps stuffing box

difficulties must be continually guarded against. One effective method of lubricating where light petroleum products are being handled, such as the distillates from steam stills, etc., is to saturate a rope of perhaps one-half an inch



Courtesy of Keystone Driller Co.

Fig. 22.—A double stroke geared head as adapted to a deep well pump. Note relative size of exposed gears. Both gear and bearing lubrication must be carefully carried out on such pumps.

in diameter with a relatively heavy grade of straight mineral gear lubricant of from 1000 to 2000 seconds Saybolt viscosity at 210° Fahrenheit. Then, by looping this rope around the rod or plunger adjacent to the stuffing box and tying the loose ends firmly to one of the bolts, the reciprocating element will slide back and forth through this lubricated rope gathering a fresh film of lubricant at each stroke to replace that which may perhaps have been "cut" or dissolved from the wearing surfaces during the period within the cylinder.

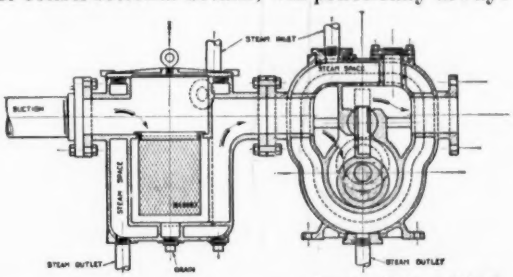
Compound Steam Cylinder Lubrication

In the lubrication of the steam end of a compound steam pump the matter of lubricating equipment is very important. Whereas the hydrostatic lubricator, or other types of independent sight feed oilers will function satisfactorily on a single expansion steam pump, where low and high pressure cylinders are involved a mechanical force feed lubricator capable of lubricating the steam both before and after it passes through the high pressure cylinder, will be a decided adjunct. The high pressure exhaust line is hardly the place for a hydrostatic lubricator, and the use of hand pumps, etc., may result in alternate over and under lubrication of the low pressure cylinder, especially where a number of pumps are involved and labor conditions do not permit of too careful attention. As a result, in the opinion of many pump experts a lubricator capable of delivering the requisite amount of oil for each cylinder, etc., to the respective steam line at the proper distance from the steam chest, will give the best results.

In addition with a two-compartment device it will also be possible to supply each cylinder with a different grade of oil so refined and compounded as to adequately meet the specific steam conditions involved. For example, steam at say 250 pounds pressure, perhaps superheated, should be lubricated with a straight mineral, high flash point product; on the other hand when this steam reaches the low pressure cylinder it may have become sufficiently saturated as to require a cylinder oil compounded with a certain percentage of fixed or animal oil to insure proper emulsification and lubrication of the cylinder walls, valve seats, etc.

CONCLUSION

So it will be advisable to look into the matter of pump lubrication, whatever products are being handled. It is hardly fair to process machinery to expect it to make up for the deficiencies that may be prevalent due to faulty lubricated pumps. For remember, overall plant efficiency is based on the combined productive output of all departments and all machinery. So each unit must be capable of producing its maximum. Therefore the pumps, as the salient transfer equipment involved, must not be overlooked. Effective lubrication, regardless of constructional details, will practically always



Courtesy of Kinney Mfg. Co.

Fig. 23.—A steam jacketed strainer attached to a steam heated rotary piston type of pump. This device facilitates the simultaneous pumping and straining of highly viscous fluids.

insure satisfactory results, for a well-lubricated machine seldom falls down on the job. A check-up on steam or power consumption, maintenance costs, and productive time lost due to repairs will prove our contention.

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